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G2J JGX

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(56) Documents Cited

GB 2260840 A

GB 2235295 A

GB 2065373 A

GB 2027551 A

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US 3774021 A

(58) Field of Search

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INT CL<sup>6</sup> G02B, H01H

(54) Sheet-like light guide for illuminating keypad

(57) A sheet like light guide 5 covering essentially the area of keypad 1 and made of light-conducting material, such as polycarbonate, and provided with an uneven light-transmitting and light-diffusing surface, such as roughened surface 19, against each key 7 to illuminate the key, while the surface of the light guide between the keys is essentially unilluminated. The non-illumination is provided by making the surface of light guide 5 smooth. The roughening can be made on conical surfaces 19 of apertures 13 in light guide 5, through which keys 7 are connected to the electronic parts of circuit board 20 underneath. The illumination of keys 7 and display 2 can be by the same light sources 4 and light guide 5. The keypad 1 may be part of a control panel 3 for electronic devices e.g. a mobile phone.

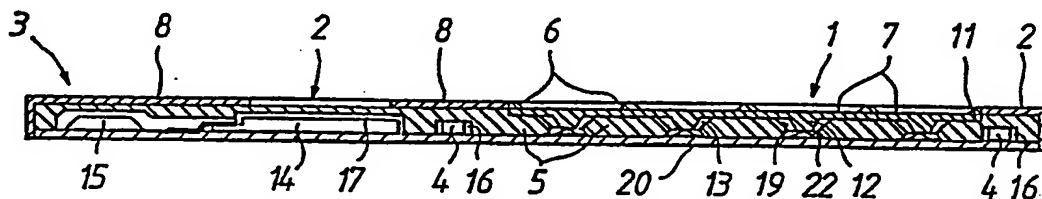


Fig. 2

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Fig.1

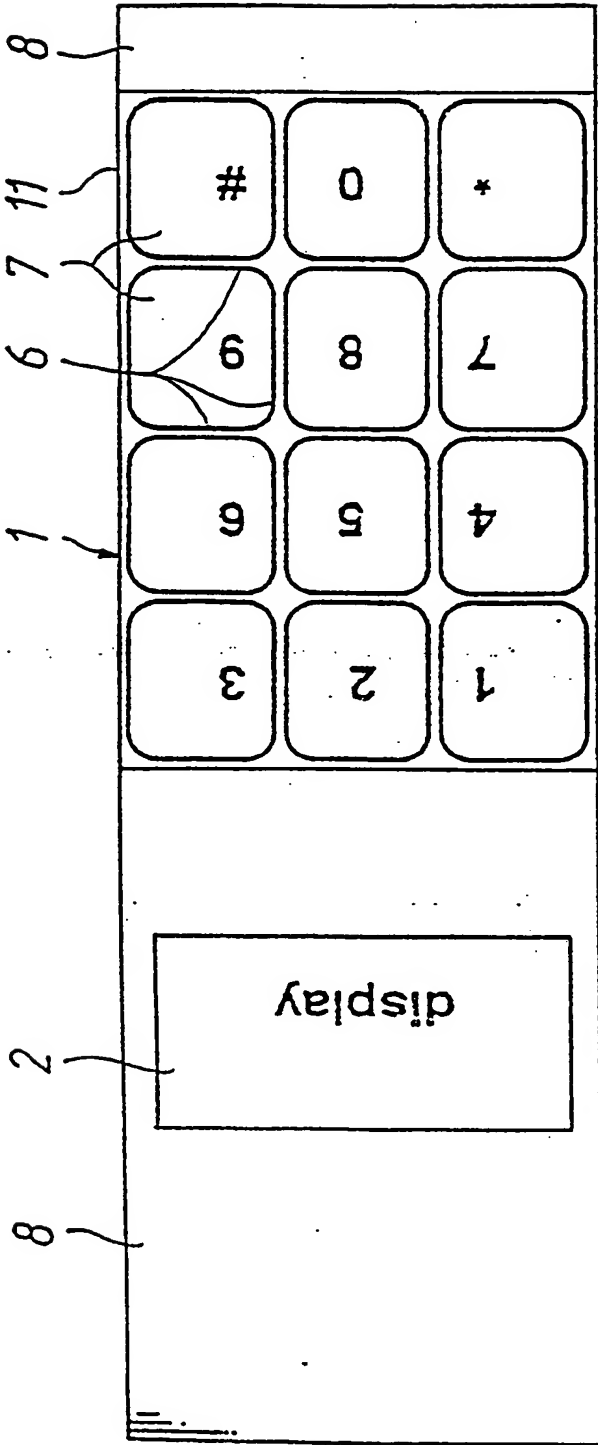
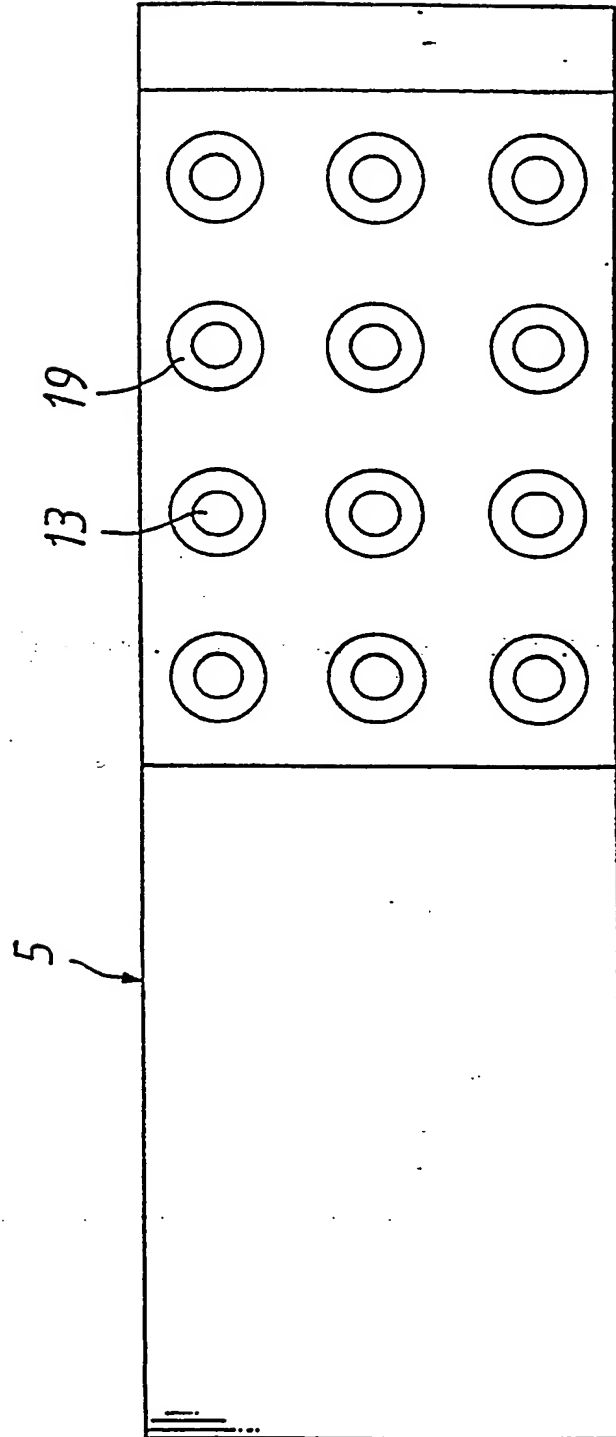
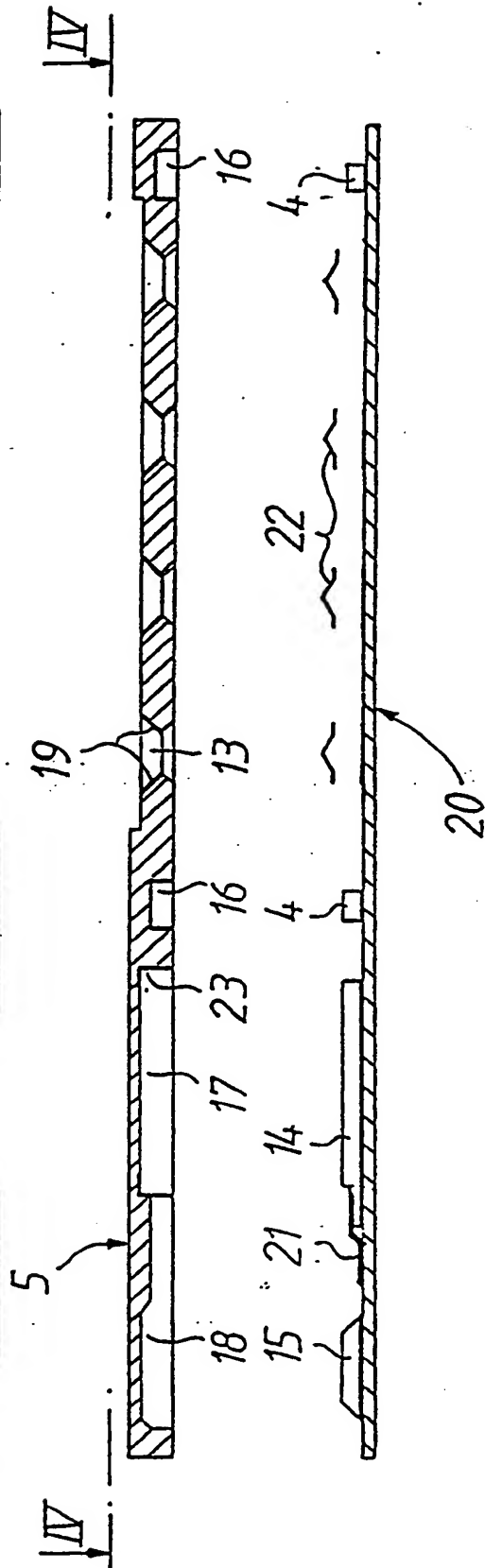
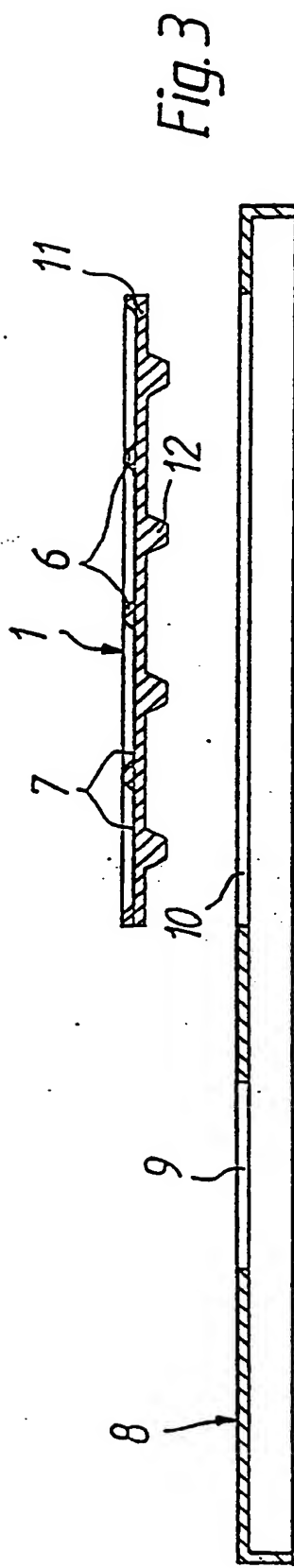
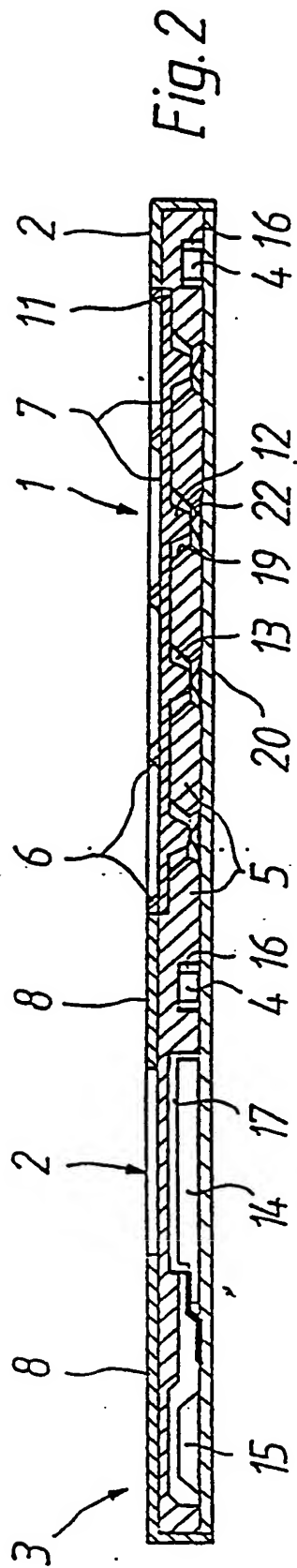


Fig.4





**LIGHT GUIDE**

This invention relates to a control panel for use in portable electronic devices, comprising one or more light sources for illuminating the keys and the display typically found on such devices. Suitable applications of the invention include portable telephones and calculators.

Some previously known solutions for illuminating keypads are disclosed in US patent publications; 4,124,879; 4,365,120; 4,636,593; 4,812,831 and 4,916,262. Publication 4,365,120 describes a solution where each key, which is made of light-transmitting material, comprises its own light source, situated in a recess formed in the back of the key. In the solution according to publication 4,124,879, light is distributed around the keypad from a light source on the side of the keypad through light-conducting channels situated between the rows of keys. The channels are provided with matt and reflecting painted surfaces for directing the light. In publication 4,636,593 the keys are part of an element made of translucent elastomeric material, and the light sources are placed between the keys in recesses formed in the element. Publication 4,916,262 discloses a structure formed of numerous superimposed, light-transmitting layers in which the keypad is illuminated by light conducting through the lowest layer of the structure and distributing over the whole area of the keypad. In the solution according to publication 4,812,831 the keypad is illuminated by electroluminescence provided by phosphorizing powder or ink contained in a layer under the keypad.

Excluding US patent publication 4,124,879, all the solutions above have light sources placed within the keypad, or arranged to be effective from under the keypad. A drawback with these solutions is that the position of the light source results in the control panel being relatively thick. In publication 4,124,879 the light source is to the side of the keypad, thus overcoming the thickness problem. This

solution, however, requires a complex channel structure to direct the light to the keys, usually with numerous surfaces painted with matt or reflecting paint.

According to the present invention there is provided a light guide for a key pad, comprising a sheet-like light-transmitting member having matted or greyed light-transmitting and light-diffusing surfaces disposed in regions corresponding to keys of a key pad for illuminating the keys of the key pad and having smooth surfaces between the regions corresponding to the keys to inhibit illumination of the surfaces between said regions.

An advantage of the invention is that it provides a simple solution for distributing light to illuminate a control panel for an electronic device and distributing light to the keypad in the lateral direction from one or more light sources situated at the edges of the keypad.

The operation of a sheet-like light guide in accordance with the invention is based on the total internal reflection of light in the sheet material in a similar manner as in light cables containing optic fibres. A beam of light which comes to the surface of the light guide in an inclined manner does not escape the light guide but is reflected back instead, and diffusion of light outside the light guide only occurs in the areas of the light guide which are made uneven for the purpose of diffusing the light. Using the solution, the illumination can be directed to each key of the keypad, while the external areas of the keys remain unilluminated. A single source of light is sufficient to illuminate the keypad, but the control panel is preferably provided with several light sources which can provide different colour light and which can be used to vary the illumination of the keypad. Suitable materials for the light guide include plastic materials, such as polycarbonate, polystyrene or polymethylmethacrylate, which are easy to cast and which transmit light well, though other materials are viable with which the above-mentioned total reflection effect is possible.

In accordance with an advantageous embodiment of the invention each aperture of the light guide corresponding to each key is provided with a roughened surface, while the surface of the light guide between the apertures is smooth. If the light guide is manufactured by casting of plastics such as polycarbonate, both the roughened surfaces on the apertures and the smooth surfaces between them can be provided by the actual casting process. A sufficiently smooth surface keeps a major part of the light beams inside the light guide so that no separate, non-transparent coating is required to keep the surface unilluminated.

The sheet-like light guide preferably comprises an opening under each key through which the key communicates with the circuit board under the light guide, the side surfaces of the openings being roughened to diffuse light. In addition, the openings expand in a concave, conical or pyramid-like manner in the direction of the surface of the control panel, whereby the inclined surfaces of the openings direct light diagonally to the keys on the surface of the control panel.

In accordance with an advantageous embodiment of the invention keys are included in a uniform, sheet-like element located on top of the sheet-like light guide, the element being generally of light-transmitting or translucent material. The said element protects the smooth surfaces of the light guide against scratching which would cause light to diffuse in spots intended to be unilluminated. The element may be a light-transmitting rubber material such as silicone.

The front surface of the element containing said keypad can be even or flat, except for ridges which are of non-transparent silicone, for example, and which form a net or similar figure on the surface of the element, separating the keys from each other. The ridges make it easier to use the keypad and they form a guard against the accidental pushing of the keys while the device is in a pocket, for instance.

In accordance with an especially advantageous embodiment the sheet-like light guide extends, in addition to the keypad, to the display included in the control panel of the device and comprises one or more roughened surfaces to illuminate the

display. This means that the keypad and the display can be illuminated using the same light source(s). In previously known solutions both the keypad and the display required separate light sources. Further, by a single casting a light guide for both the keys and the display can be fabricated.

Embodiments of the invention will now be described, by way of example only and with reference to the accompanying drawings, in which:

Figure 1 illustrates a control panel for a mobile phone which is provided with an illuminated keypad and display in accordance with the invention;

Figure 2 is an axial cross section of the control panel shown in Figure 1;

Figure 3 is an exploded view of Figure 2 showing the components which constitute the control panel; and

Figure 4 illustrates the light guide included in the control panel, as viewed in direction IV-IV, of Figure 3, i.e. from above.

Referring to Figures 1 and 2, there is shown a control panel 3 comprising a keypad 1, a display 2, light sources 4 and a substantially planar light guide 5, used to illuminate the display 2 and keys 7.

Referring also to Figure 3, there is shown on the uppermost part of control panel 3 a sheet-like cover 8 made from non-transparent material. The cover 8 includes openings 9, 10 for the display 2 and the keypad 1 respectively.

The keypad 1 comprises a planar element 11 with mutually perpendicular ridges 6 defining the edge of the keys 7. The lower surface of the planar element 11 includes projections 12 below each key 7. The planar element 11 is preferably made of translucent silicone, except for the ridges 6 and any numbers and other symbols painted on keys 7, which are non-translucent.

Referring to Figure 3 and Figure 4, there is shown a planar light guide 5 in cross-section and from above respectively. The light guide 5 is preferably made of polycarbonate or a corresponding light-transmitting material to permit illumination of the display 2 and the keypad 1 with light from light sources 4. The light guide 5 is provided with concave apertures 13 situated below each key 7 of keypad 1 and from the lower surface with recesses 16-18 for accommodating the light sources 4, a display element 14 and a display control circuit 15. The light guide 5 is preferably fabricated by casting and comprises roughened cast surfaces against the concave apertures 13 and recesses 16, 17, while the remaining surfaces are cast smooth. Light is guided throughout the light guide 5 using the method of total internal reflection, in which light is reflected back from smooth surfaces of the light guide without the light transmitting outside the light guide. Light transmission is only effective on the roughened surfaces of the light guide where the light is diffused and consequently the light only illuminates the keys 7, and the display element 14. The concave apertures 13 in the light guide below the keys 7 have a conical shape such that they increase in radius towards the keys 7 the purpose of which is to direct light diagonally from the roughened conical surfaces 19 to the keys 7 on the surface of the control panel 3.

Preferably the light guide 5 extends over the area of the keypad as a plate-like element which except for the openings for the keys is of a unitary configuration. The keys 7 and the concave apertures 13 are arranged in longitudinal and transversal rows corresponding to the usual arrangement of the keys, thus defining a rectangular area for the keypad. The light guide 5 acts as a means for distributing the light through the channels between the rows of the concave apertures 13 to the entire area of the keypad. For effective light distribution the channels should be wide enough in comparison with the size of the concave apertures 13. This applies in particular to channels extending in a direction perpendicular to the direction from which the light is sourced. Preferably the cross-sectional area of a channel between a pair of adjacent concave apertures is at least equal to the cross-sectional area of one of the concave apertures. Referring now to the areas of the concave apertures and the keypad as seen in Figures 1 and 2,

the sum of all the areas corresponding to the concave apertures is preferably no more than about 25% of the total area of the keypad, thus leaving at least 75% of the keypad's area for the light channels extending between and around the concave apertures. The percentage area of the keypad taken up by the keys, however, is significantly larger which leads to less area on the keypad being unused.

The base of the control panel 3 comprises a printed circuit board 20 provided with electronic components. Referring to Figures 2 and 3, light sources 4 are provided on circuit board 20 on either side of the keypad 1 such that one of the light sources is situated between the keypad 1 and the display 2. Light source 4 may be a light bulb, a fluorescent tube or a light emitting diode. The light may be white or monochromatic, and in accordance with the invention the device can be provided with several light sources of different wavelength, which can be used simultaneously or separately to alter the lighting of keypad 1. If desired, a fluorescent coating may be applied to the roughened surfaces of apertures 13 of the light guide 5 or each key 7 may be dyed with a different colour. Display element 14 situated below the display 2 on circuit board 20 can be in the form of a liquid crystal display which is connected to display control circuit 15 via a lead 21. Metal domes 22 are situated between projections 12 and circuit board 20, the dome being compressed when a key is pushed, either connecting or disconnecting an electrical contact provided on the circuit board.

The components 1, 8, 5 and 20 of the control panel shown in Figure 3 are attached to each other by gluing to form the assembly shown in Figure 2. Keypad 1 is fitted into opening 10 in the cover 8 such that the cover 8 and the keypad 1 together cover the light guide 5 beneath them. The keys 7 communicate with the electrical contacts of the circuit board 20 through the concave apertures 13 of the light guide 5. The light sources 4 are situated within the recesses 16 in the light guide 5 and the display element 14 is situated in recess 17 below display 2 in such a manner that the light guide functions as a light-transmitting window protecting the display element 14. The light from light sources 4 is transmitted through the

roughened surfaces of recesses 16 and into the light guide 5. The illumination of the keys 7 is then achieved by light transmitting out of the light guide via the roughened conical surfaces 19 of the concave apertures 13. Similarly the display element 14 in display 2 is illuminated via roughened edge surfaces 23 of recess 17.

In view of the foregoing description it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention. For example the specific embodiment refers to using rough surfaces, alternatively the illuminating parts of light guide 5 can be provided with relatively coarser roughness, such as different regular-shaped ridges cast on the light guide's surface. Furthermore, it may be advantageous to mould the light guide 5 so that it can be situated under display element 14.

The scope of the present disclosure includes any novel feature or combination of features disclosed therein either explicitly or implicitly irrespective of whether or not it relates to the claimed invention or mitigates any or all of the problems addressed by the present invention.

**CLAIMS**

1. A light guide for a key pad, comprising a sheet-like light-transmitting member having matted or greyed light-transmitting and light-diffusing surfaces disposed in regions corresponding to keys of a key pad for illuminating the keys of the key pad and having smooth surfaces between the regions corresponding to the keys to inhibit illumination of the surfaces between said regions.
2. A light guide according to Claim 1, wherein the sheet-like light guide further comprises an aperture in said regions adapted to enable a corresponding key to communicate with a circuit board disposed the light guide, and a side surface of said apertures are matted or roughened to diffuse light incident thereon.
3. A light guide according to Claim 2, wherein the apertures are generally concave and expand conically in a direction towards a major surface of the sheet-like light guide such that the side surface of the apertures direct light diagonally to the keys.
4. A control panel comprising a light guide according to any of the preceding Claims, wherein there are provided keys formed in a uniform, sheet-like element disposed on a top surface of the sheet-like light guide, the element being generally of light-transmitting or translucent material, and the front surface of the element which is otherwise even or flat, comprising non-translucent ridges which form a net or similar figure on the surface of the element, separating the keys.
5. A control panel according to Claim 4, wherein each key comprises a projection disposed in a corresponding aperture of the light guide and projecting from the sheet-like element, a movement of the projection causing an electric contact to be created or disconnected in a circuit board disposed under the light guide.

6. A control panel according to Claim 4 or Claim 5, further comprising at least two light sources disposed at opposing edges of the sheet-like element and from which the light guide distributes light to the keys.

7. A control panel according to any of Claims 4 to 6, wherein the sheet-like light guide extends, in addition to the keys, also to a display disposed in the control panel, and comprises one or more light-transmitting and light-diffusing surfaces to illuminate the display.

8. A control panel according to Claim 7, wherein the light guide extends over the top of the display element in the display such that the light guide forms a light-transmitting window for the display.

9. A control panel according to Claim 8, wherein the display element is situated in a recess formed in a back surface of the light guide, the side surfaces of the recess being matted or roughened to illuminate the display.

**Relevant Technical Fields**

Search Examiner  
 MR C ROSS

(i) UK Cl (Ed.N) G2J (JGX); H1N (NPW)

(ii) Int Cl (Ed.6) G02B, H01H

Date of completion of Search  
 8 MARCH 1995

**Databases (see below)**

(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

Documents considered relevant following a search in respect of Claims :-  
 1-9

(ii)

**Categories of documents**

- |   |   |
|---|---|
| <b>X:</b> Document indicating lack of novelty or of inventive step.   | <b>P:</b> Document published on or after the declared priority date but before the filing date of the present application.        |
| <b>Y:</b> Document indicating lack of inventive step if combined with one or more other documents of the same category. | <b>E:</b> Patent document published on or after, but with priority date earlier than, the filing date of the present application. |
| <b>A:</b> Document indicating technological background and/or state of the art.   | <b>&amp;:</b> Member of the same patent family; corresponding document.   |

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2260840 A	(EUROTHERM) see especially parts 5, 20	1 at least
X	GB 2235295 A	(TECHNOPHONE) see especially page 5 line 4 and page 10 line 16 on	1 at least
X	GB 2065373 A	(SHIN-ETSU) see especially page 2 line 90 on	1 at least
X	GB 2027551 A	(DECCA	1 at least
X	US 5050946	(GOMPAQ) see especially roughened facets 116, column 8 lines 36-37	1 at least
X	US 3774021	(BELL TELEPHONE) see especially Figure 4	1 at least